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Forecasting the Philippines Electronic Export Goods using Autoregressive Integrated Moving Average Modeling

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A B S T R A C T

The main objective of this study is to predict the electronic export good of the Philippines. The data were gathered from Philippine Statistic Authority with 88 observations from first quarter of 2000 to third quarter of 2022. This research used box Jenkins in forecasting the electronic export of the Philippines. The researchers identify all the possible model by using tests such as ADF,PP and KPSS. The researchers estimated all the identified possible ARIMA models to identify the best and fitted model for forecasting. ARIMA (2,2,2) for semi-conductor, ARIMA (1,2,1) for electronic data process, ARIMA (4,2,7) for consumer electronic and ARIMA (1,1,1) for control instrument were the best fitted model in forecasting the electronic export of the Philippines. Using the ARIMA model, the researchers was able to forecast the electronic export of the Philippines for the next 3 years.

Keywords: ARIMA Model, Electronic export, Forecasting

INTRODUCTION

According to bsp.gov.ph, long before the Spanish conquered the Philippines, Filipinos are already into exporting of goods to our neighboring countries like China and Thailand. Our ancestors called it Barter trade. As the years goes by, the Philippines continues to open their market to other countries. In fact, Philippines is an active member of international trade organization such as Asia-Pacific Economic Cooperation (APEC), The association of Southeast Asian Nations (ASEAN), and World Trade Organization (WTO). United States, China, Japan, and Thailand are the top four countries where our product go. As an active member of the different trading organization, Philippines is into exporting of products.

Electronic goods are one of the top exported goods of the Philippines. The Semiconductor and Electronics Company in the Philippines Foundation Inc. (SEIPI) is the largest organization of Foreign and Filipino electronic companies in the Philippines, this organization aims to make the Philippines globally competitive business environment for semiconductor and electronics technologies. In November 2022 the electronic exports rose by 22.18%, from US$3.99 billion in November 2021 to US$4.88 billion in November 2022. The Exports grew was led by semiconductor component (26.35%), control and instrumentation (22.69%) and medical/industrial instrumentation (7.98%). The top five export in November 2022 namely Hong Kong (21.85%). The USA (13.96%), China (9.36%), Japan (7.16%) and Singapore (6.73%).

In this, research, the researchers will forecast the electronic export of the Philippines from fourth quarter of 2022 to fourth quarter of 2025. This research will help the Philippine economy specifically in exporting electronic goods of the Philippines.

OBJECTIVE AND STATEMENT OF THE PROBLEM

The core objective of this study is to forecast the electronic export goods of the Philippines. In order to meet the objective, the following questions needs to be answered.

1. What is the trend of the graph of Electronics Export Goods of the Philippines?

1. 1 Semiconductor	1.3. Consumer Electronic
1.2. Electronic data process	1.4. Control instrumentation

2. What ARIMA Model is best fitted in forecasting the electronic export goods of the Philippines?

3. What are forecasted values of Electronic Exports Goods of the Philippines from Quarter four od 2022 to Quarter four of 202

CONCEPTUAL FRAMEWORK

The researchers used a conceptual framework as guide in Forecasting Electronic Export Goods of the Philippines. The figure below shows the process flow of this study.

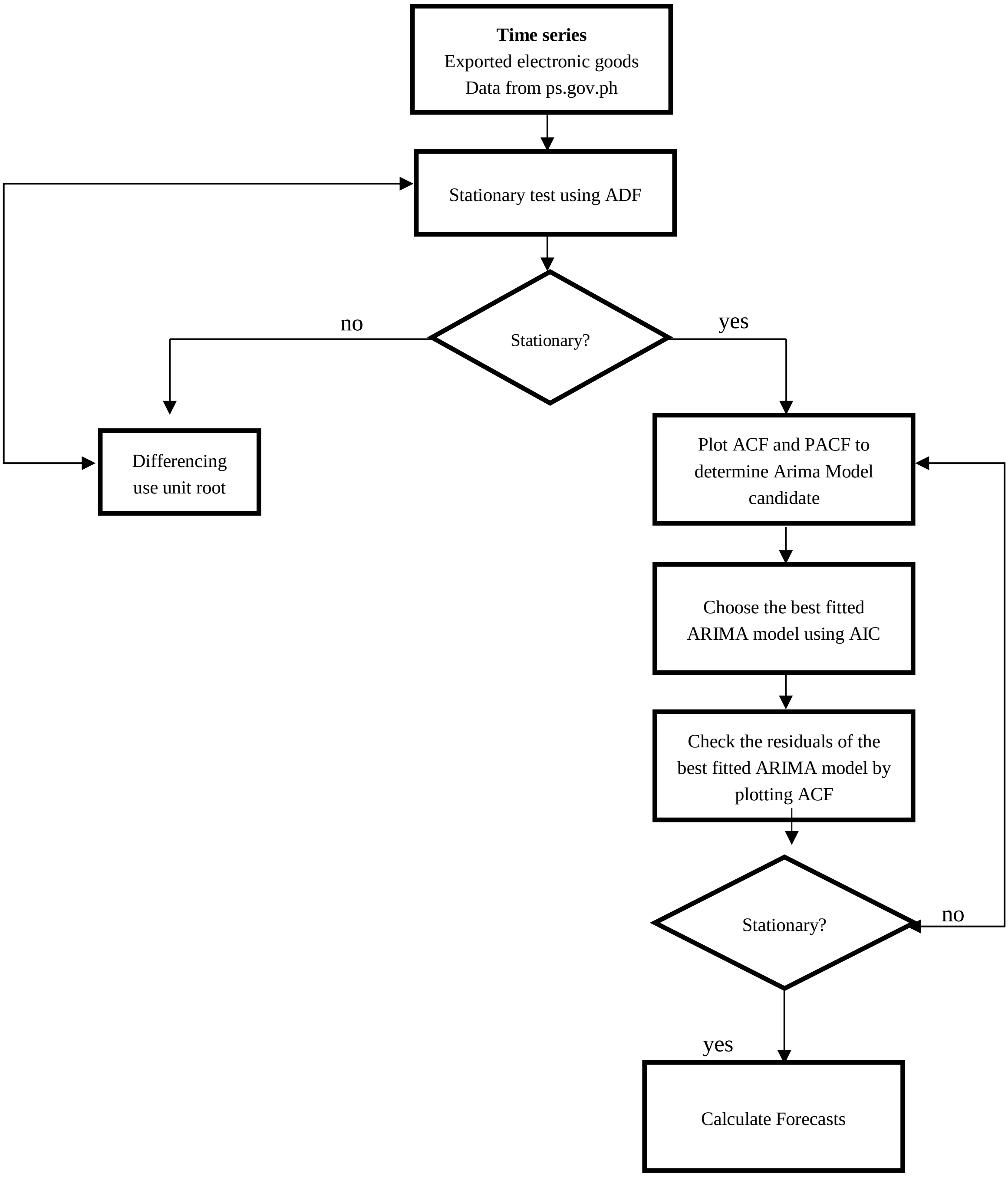

Figure 1. Conceptual Framework

SCOPE AND LIMITATION

This study was conducted to forecast the value of the Electronic Export Goods of the Philippines. The research uses the quarterly data of Electronic Export Goods from 2000 to 3rd quarter of 2022. The data gathered from Philippine Statistic Authority (https://psa.gov.ph). This study will forecast the value of Electronic Export Goods from Quarter 4 of 2022 to Quarter 4 of 2025.

REVIEW OF RELATED LITERATURE

This section of the paper will provide an overview of the current knowledge of the topic and allowing to identify relevant theories, methods and gaps that would help to determine the nature of the research by studying a previous work and findings to create a full understanding of the developments in this field.

Last 2021, the Philippine electronics export revenues increased by a record-high 12.9% from the year before, despite the pandemic-related curbs, according to an industry report. In 2021, the country's semiconductor and electronics sector shipped $45.92 billion worth of goods. The 2020 lockdowns disrupted the industry's pre-pandemic rise, posing record earnings for three years in a row. In 2020, earnings dropped by around 6% to $40.67 billion. The record revenues in 2021 means electronics now account for more than 60% of the country's total export receipts of $74.64 billion in 2021.

It is stated in the report that a key driver for the rise in demand is electronic components used in telemedicine, work-from-home arrangements, and artificial intelligence (AI), among others. Electronics sectors that posted growth in exports last year were telecommunications (138%), medical or industrial instrumentation (37.49%), electronic data processing (29.51%), consumer electronics (19.45%), office equipment (19.32%), control and instrumentation (12.92%), and components or devices or semiconductors (7.37%).

It is expected that this year, export revenues could grow by 10%. The projection depends on improvements to inbound and outbound logistics flows, supply chains, the health of the population as well as the reopening of the country. The report also suggests that country could do much more. Most of the electronics manufacturing companies in the country are within the Philippine Economic Zone Authority (PEZA) locations. A key challenge is its ability to attract as many new investments as its peers in Southeast Asia.

In the study of Jackie D. Urrutia, Francis Leo T. Mingo, and Ciandreu Noah M. Balmaceda, they forecast the Income tax revenue of the Philippines using the autoregressive integrated moving average modeling. The study obtained model was ARIMA (0,1,1) and concluded with 3 significant factors that can predict the income tax revenue.

In the paper of Jamal Fattah, Latifa Ezzine, Zineb Aman, Haj El Moussami and Abdeslam Lachhab. they forescat the demand in food industry using ARIMA Modeling. The result obtained proves that the chosen ARIMA Model which is the ARIMA (1,0,1) can be used in forecasting the future demand in food manufacturing. That that theses result can help the managers in food manufacturing industry in their decision making.

In the study of Ramlan, M. N (2021), Evaluating forecast Performance of Malaysian goods export for 2021-2022 with box-jenskin methodology and ARIMA model. They concluded that the best ARIMA model is (2,1,2). The result is very close to the actual growth rate values of export goods. They also concluded that box-jenkins methodology is a perfect forecasting tools for exports goods and it is reliable method for forecasting considering the ifferencce between actual and forecast result is very close.

In the paper of U. Baser, M. Bozoglu, N. Eroglu and B. Kilic Topuz in the study of Forecasting chestnut production and export of turkey using ARIMA Model A, the model ARIMA (1,1,1) is the best fitted model to use in the study. The projection of the agricultural commodities play vital role in the adjustment of supply and demand in the future.

MATERIALS AND METHODS

This chapter focuses on the methods used by the researcher in this study. The study used descriptive design method to forecast the electronic esport of the Philippines. The researcher used secondary data that was gathered from various sources such as government reports and other publications.

The researcher downloaded the data to be use in this study and then, data was transferred into an excel spreadsheet and then uploaded the data in Eviews. The researchers used the Autoregressive Integrated Moving Average methodology, tested the assumption to satisfy the data before forecasting the electronic export of the Philippines.

Statistical Treatment

The researchers used Box Jenkin in treating the data. Box Jenkins is a mathematical model designed to forecast data ranges based on inputs from a specified time series. The Box-Jenkins Model can analyze several different types of time series data for forecasting purposes.

1. Identification of ARIMA Model

Augmented Dickey Fuller Test

ADF (Augmented Dickey-Fuller) test is a statistical significance test which means the test will give results in hypothesis tests with null and alternative hypotheses. As a result, we will have a p-value from which we will need to make inferences about the time series, whether it is stationary or not.

Before going into the ADF test, we must know about the unit root test because the ADF test belongs to the unit root test.

A simple AR model can be represented as:

$$Y_t = \rho y_t - 1 + u_t$$

where

- y_t is variable of interest at the time t
- ρ is a coefficient that defines the unit root
- u_t is noise or can be considered as an error term.

If ρ = 1, the unit root is present in a time series, and the time series is non-stationary.

Autoregressive Integrated Moving Average

A statistical analysis model that uses time series data to predict future trends. It is a form of regression analysis that seeks to predict future movements along the seemingly random walk taken by stocks and the financial market by examining the differences between values in the series instead of using the actual data values. Lags of the differenced series are referred to as "autoregressive" and lags within forecasted data are referred to as moving average. (Investopedia, Definition of Autoregressive Integrated Moving Average ARIMA) The general form for the ARIMA model is:

$$Y_t = \beta_1 Y_{t-1} + \beta_1 Y_{t-2} + \cdots + \beta_0 Y_0 + \varepsilon_t$$

$$Y_t = \beta_1 Y_{t-2} + \beta_1 Y_{t-3} + \cdots + \beta_0 Y_0 + \varepsilon_{t-1}$$

An ARIMA model is commonly denoted ARIMA(p,d,q). If any of p,d, or q are zero, the corresponding letters are often dropped. For example, if p and d are zero, then model would be denoted MA(q)

2. Estimation of the ARIMA Model Candidate

Akaike Information Criterion

Akaike's information criterion (AIC) compares the quality of a set of statistical models to each other. For example, you might be interested in what variables contribute to low socioeconomic status and how the variables contribute to that status. Let's say you create several regression models for various factors like education, family size, or disability status; The AIC will take each model and rank them from best to worst. The "best" model will be the one that neither under-fits nor over-fits.

3. Diagnostic and Forecasting

The Ljung Box test (sometimes called the modified Box-Pierce, or just the *Box test*) is a way to test for the *absence* of serial autocorrelation, up to a specified lag *k*.

The test determines whether or not errors are iid (i.e. white noise) or whether there is something more behind them; whether or not the autocorrelations for the errors or residuals are non zero. Essentially, it is a test of *lack* of fit: if the autocorrelations of the residuals are very small, we say that the model doesn't show 'significant lack of fit'.

Eviews

EViews is a modern econometric, statistics, and forecasting package that offers powerful analytical tools within a flexible, easy-to-use interface. EViews can help in managing data quickly and efficiently. Perfom econometric and statistical analysis, generate forecasts or model simulations, and produce high quality graphs and tables for publication or inclusion in other applications.

Eviews is simplies every step of the process, from data input and import, to data visualization, statistical analysis, estimation, forecasting and model solving, publication quality presentation output.

RESULTS AND DISCUSSIONS

This section will explain the historical behavior of the electronic export of the Philippines from the first quarter of 2000 up to the third quarter of 2022. This section will also tackle the ARIMA best models used to forecast the electronic export of the Philippines and the behavior of the forecasted graph within the span of fourth quarter of 2022 up to the fourth quarter of 2025.

Trends of the Graph

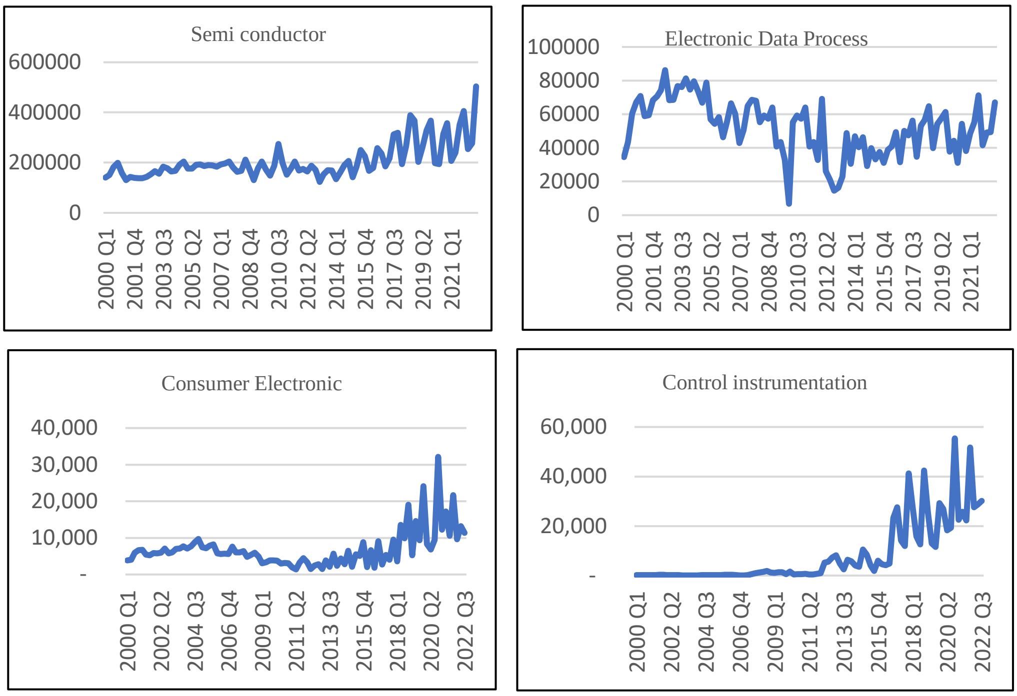

Figure 2. Trend of the graph of Philippine Electronic export from 2000Q1 – 2022Q3

The graph on the fig. 2 refers to the behavior of electronic export from quarter one of 2000 to third quarter oof 2022. As observed, in general, increasing pattern with fluctuation have seen in electronic export of the Philippines. The four graph show that unstable movement of the electronic export of the Philippine over the past 22 years. During the third quarter of 2010 and quarter 2 of 2012, the electronic data process of the Philippines decreased massively while the other category of electronic export shows positive movement during those years. The control instrumentation graph shows that there is no movement in control instrumentation export from quarter 1 of 2000 to quarter 2 of 2011. By the year 2015, the four graphs show the positive movement of electronic export of the Philippines.

Model Identification

The researchers select the AR and MA that has the lowest AIC which are AR(2) and MA(2) for semiconductor, AR(1) and MA(1) for electronic data process, AR(4) and MA(7) for consumer electronic and AR(A) and MA(1) for control instrumentation.

TABLE 1. Best fit ARIMA Model in forecasting the electronic export of the Philippines

ELECTRONIC EXPORT	**ARMINA MODEL**	**AKAIKE**	**SCHWARZ**	**HANNAN-QUINN**
Semiconductor	ARIMA (2,2,2)	25.55771	25.66956	25.60280
Electronic data process	ARIMA (1,2,1)	21.78191	21.89375	21.82699
Consumer electronic	ARIMA (4,2,7)	19.89585	20.0077	19.94094
Control instrumentation	ARIMA (1,1,1)	20.65663	20.76773	20.70143

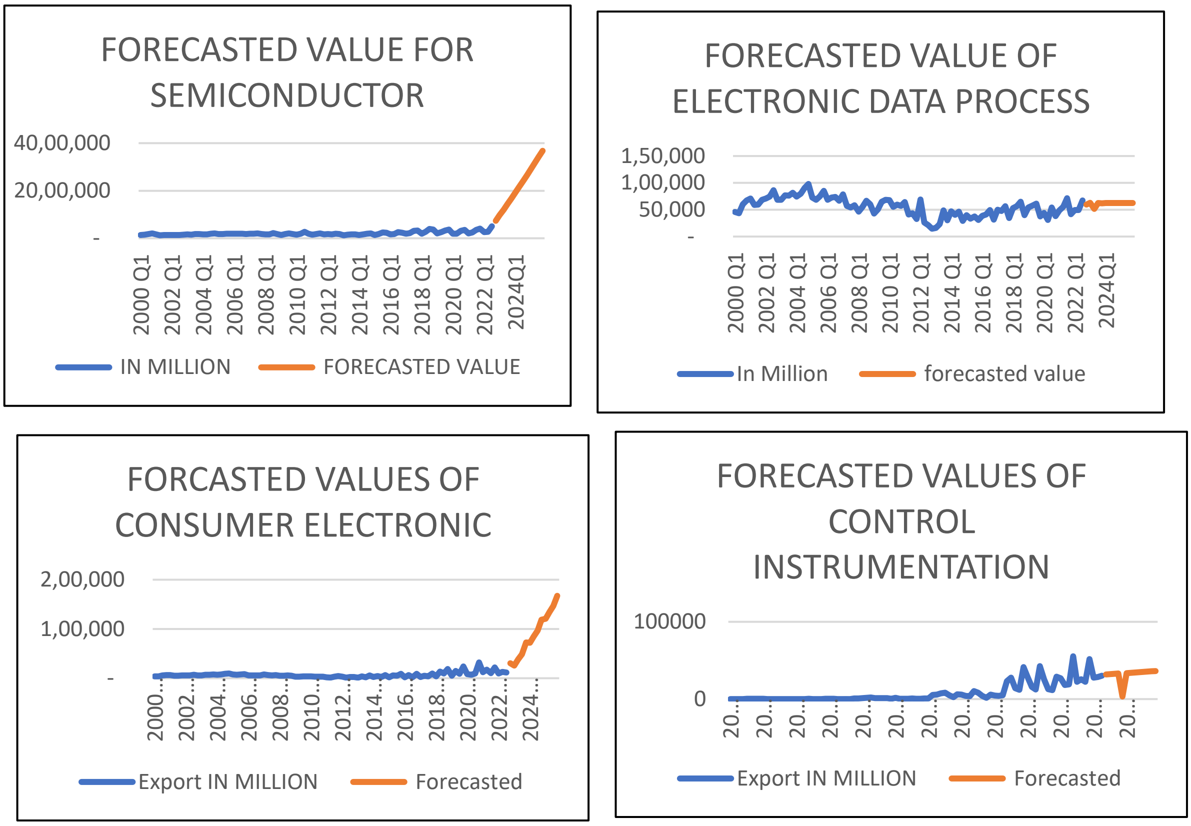

Figure 3. Forecasted Trend of the graph of Philippine Electronic export

The graph on the figure 2 refers to the historical and forecasted behavior of electronic export of the Philippines in respect to date in 2000-2025. As observed in the graph. The graph of semiconductor and consumer electronics show an increasing trend in the future. In the forecasted graph of electronic data process shows that there will be no movement until the fourth quarter of 2025 and in graph of forecasted value of control instrumentation shows fluctuation on 2023 and eventually will recover on the first quarter of 2024.

CONCLUSION AND RECOMMENDATION

In conclusion, the best fit ARIMA model in forecasting the electronic export goods of the Philippines are ARIMA (2,2,2) for semiconductor, ARIMA (1,2,1) for electronic data process, ARIMA (4,2,7) for consumer electronic and ARIMA (1,1,1) for control instrumentation. This ARIMA models applied for foreccasting the electronic export of the Philippine gave reasonable and acceptable forecast for the next three years. The predicted forecast using the four models shows positive upward trend with fluctuation for a shor period of time for the next 3 yearrs.

This research mmay help the economist as well as the inverstod ion making decision regarding electronic business.

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FORECASTING INCOME TAX REVENUE OF THE PHILIPPINES USING AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) MODELING: A TIME SERIES ANALYSIS

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Appendices A. Original Data

National Accounts of the Philippines
Unit: In million Philippine pesos
As of November 2022

Table 7.1.1 Exports of Goods
Q1 2000 to Q3 2022
At Current Prices

	2000				2001				2002				2003			
Items	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Electronic Products	199,653	208,077	262,787	289,490	253,351	209,095	222,394	229,314	228,391	232,313	252,035	239,845	252,285	252,799	279,848	281,924
Components/devices (semic	140,582	151,097	182,415	198,902	157,851	130,151	143,333	139,593	137,405	137,980	143,339	153,856	166,050	155,961	183,287	178,035
Electronic data processing	45,931	43,423	60,304	67,307	70,877	58,801	59,447	68,469	70,720	74,331	86,219	68,335	68,489	76,748	76,159	81,397
Consumer electronics	3,808	4,017	5,935	6,650	6,695	5,387	5,260	5,825	5,771	5,980	7,040	5,784	6,039	6,961	7,051	7,656
Control instrumentation	133	157	174	193	232	230	264	270	222	160	199	125	94	61	59	57

	2004				2005				2006				2007			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Electronic Products	260,581	270,615	310,457	332,086	270,573	264,727	288,425	301,863	275,134	284,307	284,914	271,163	297,980	274,022	280,780	264,390
Components/devices (semic	164,500	167,031	192,031	203,875	176,134	176,000	191,275	192,451	186,424	190,304	188,944	183,357	193,085	196,550	204,855	181,057
Electronic data processing	74,579	79,756	90,707	97,962	72,380	68,322	75,223	85,017	68,670	72,564	73,773	66,936	78,826	57,001	54,285	58,368
Consumer electronics	7,067	7,651	8,825	9,706	7,430	7,164	7,826	8,256	5,765	5,633	5,688	5,555	7,630	6,075	6,023	6,392
Control instrumentation	68	115	151	234	213	190	194	254	303	310	183	71	35	213	629	890

	2008				2009				2010				2011			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Electronic Products	231,590	249,046	309,360	258,741	191,403	247,865	293,158	263,164	240,087	261,117	352,777	274,202	233,304	235,967	272,503	216,609
Components/devices (semic	163,537	167,829	211,845	172,407	130,913	177,669	204,837	171,845	148,204	187,783	273,970	197,569	152,470	175,720	204,639	168,013
Electronic data processing	46,343	55,182	66,534	60,277	42,895	50,586	64,983	68,572	67,947	55,264	59,242	57,381	64,096	40,799	43,550	32,736
Consumer electronics	4,779	5,352	5,977	4,912	3,096	3,291	3,876	3,848	3,729	2,979	3,150	3,033	1,958	1,386	3,220	4,428
Control instrumentation	1,363	1,519	1,911	1,169	1,125	1,373	1,289	611	1,611	412	527	598	732	389	408	664

	2012				2013				2014				2015			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Electronic Products	265,904	213,391	235,305	212,991	176,585	200,006	242,474	228,124	209,315	220,141	261,889	271,769	221,891	243,698	318,819	304,928
Components/devices (semic	175,528	164,615	187,238	171,634	129,321	153,378	170,346	168,691	133,779	160,805	189,926	206,288	142,082	183,446	250,741	226,577
Electronic data processing	69,159	26,249	21,094	14,606	16,237	22,908	48,740	30,489	46,850	40,480	46,358	29,176	39,794	33,277	37,666	31,124
Consumer electronics	3,315	1,516	2,440	2,797	1,481	3,875	2,062	5,676	2,364	4,367	2,774	6,427	2,131	5,487	5,087	8,810
Control instrumentation	898	5,208	5,598	7,316	8,194	4,835	2,563	6,346	5,776	4,066	3,560	10,522	8,431	4,093	1,852	5,928

	2016				2017				2018				2019			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Electronic Products	246,749	249,295	345,694	328,258	303,773	307,623	415,790	442,360	322,582	387,026	508,011	506,816	331,239	394,146	453,049	499,294
Components/devices (semic	167,752	179,315	257,254	235,896	185,323	217,490	312,112	319,166	193,861	266,871	389,641	367,154	202,521	261,204	329,247	366,881
Electronic data processing	38,888	40,883	49,332	31,413	50,109	47,504	56,249	34,636	53,136	56,601	64,831	39,845	54,196	57,511	61,282	37,685
Consumer electronics	1,992	6,621	1,844	9,059	2,722	5,338	4,067	9,569	3,616	13,564	9,848	19,019	5,222	14,612	9,316	24,136
Control instrumentation	4,585	4,146	4,786	23,318	27,556	14,074	11,975	41,257	27,983	15,745	12,526	42,474	25,494	12,946	11,558	29,185

	2020				2021				2022		
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Electronic Products	321,102	269,773	425,932	515,426	333,280	365,327	485,668	564,985	405,009	403,896	642,700
Components/devices (semic	197,478	194,441	313,734	357,109	206,753	239,518	350,527	405,540	254,544	276,678	503,826
Electronic data processing	44,177	31,173	54,344	38,232	48,653	55,247	71,181	41,538	49,233	49,349	67,124
Consumer electronics	8,294	6,793	9,483	32,122	12,267	17,174	10,539	21,673	9,576	13,172	11,338
Control instrumentation	26,946	18,256	19,243	55,394	22,560	25,703	22,255	51,741	27,623	28,715	30,190

Appendices B. Checking of ARIMA MODEL

Failed to reject the Null Hypothesis, the data has unit root. With this, ARIMA will be used.

Null Hypothesis: SEMI_CONDUCTOR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.779214	0.2088
Test critical values:	1% level	-4.063233	
	5% level	-3.460516	
	10% level	-3.156439	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SEMI_CONDUCTOR)
Method: Least Squares
Date: 10/02/23 Time: 13:30
Sample (adjusted): 2000Q2 2022Q3
Included observations: 90 after adjustments

Null Hypothesis: CONSUMER_ELECTRONIC has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.255184	0.8920
Test critical values:	1% level	-4.066981	
	5% level	-3.462292	
	10% level	-3.157475	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CONSUMER_ELECTRONIC)
Method: Least Squares
Date: 10/02/23 Time: 13:32
Sample (adjusted): 2001Q1 2022Q3
Included observations: 87 after adjustments

Null Hypothesis: CONTROL_INSTRUMENTATION has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.458699	0.8361
Test critical values:	1% level	-4.068290	
	5% level	-3.462912	
	10% level	-3.157836	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CONTROL_INSTRUMENTATION)
Method: Least Squares
Date: 10/02/23 Time: 13:33
Sample (adjusted): 2001Q2 2022Q3
Included observations: 86 after adjustments

Null Hypothesis: ELEC_DATA_PROCESS has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=11)

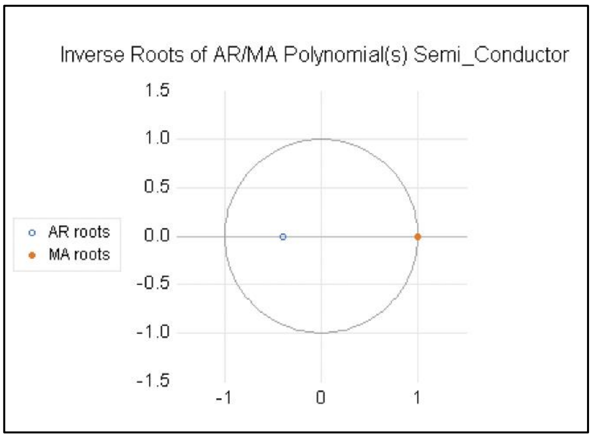
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.734116	0.7276
Test critical values:	1% level	-4.066981	
	5% level	-3.462292	
	10% level	-3.157475	

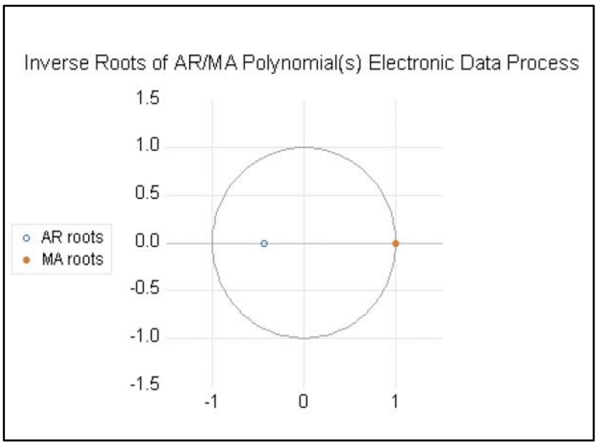
*MacKinnon (1996) one-sided p-values.

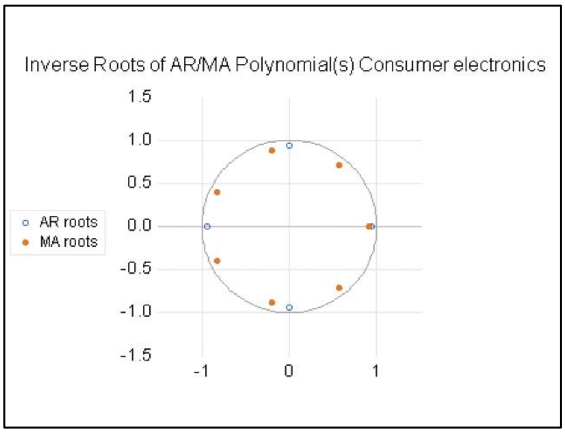
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ELEC_DATA_PROCESS)
Method: Least Squares
Date: 10/02/23 Time: 13:34
Sample (adjusted): 2001Q1 2022Q3
Included observations: 87 after adjustments

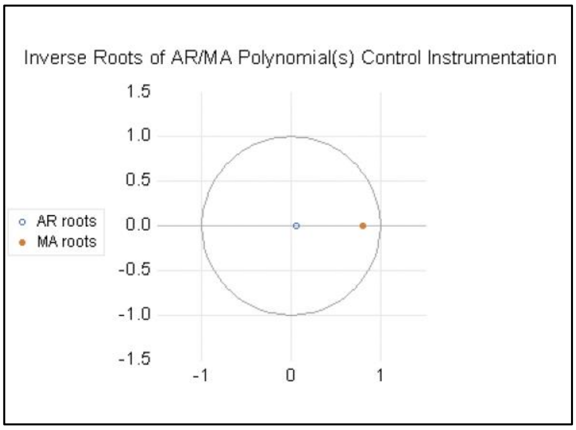
Appendices C. DIAGNOSTIC AND FORECASTING

Accept the Null Hypothesis: Residuals are white noise









Appendices D. FORECASTED VALUES OF ELECTRONIC EXPORT OF THE PHILIPPINES

TABLE 2. Forecasted values of exported Semiconductor

QUARTERS	2022	2023	2024	2025
1	-	965,424	1,917,830	2,909,180
2	-	1,199,874	2,162,016	3,163,103
3	-	1,436,759	2,408,637	3,419,460
4	733,408	1,676,077	2,657,692	3,465,817

TABLE 3. Forecasted values of exported electronic data process

QUARTERS	2022	2023	2024	2025
1	-	62,929	62,230	62,437
2	-	51,546	62,242	62,490
3	-	62,251	62,327	62,543
4	59,505	62,044	62,376	62,593

TABLE 4. Forecasted values of exported consumer electronic

QUARTERS	2022	2023	2024	2025
1	-	25,692.61	72,039.17	120,933.10
2	-	38,191.81	84,961.21	134,286.90
3	-	48,936.04	96,496.41	146,549.70
4	30,703.82	72,775.47	118,574.70	167,305.30

TABLE 5. Forecasted values of exported control instrumentation

QUARTERS	2022	2023	2024	2025
1	-	32,231	33,688	35,144
2	-	32,596	34,052	35,508
3	-	32,960	34,416	35,872
4	31,892	3,324	34,780	36,2369